Appendix A Detailed Model Description

This report describes the variables, constraints, and other attributes in the linear program formulation of ReEDS. It outlines, in order:

1. Subscripts (variables and constraints)
2. Major decision variables
3. The objective function
4. Constraints
5. Glossary of parameters

A.1 Subscripts

Variables, parameters, and constraints are all subscripted to describe the space over which they apply. The various sets are listed below.

A.1.1 Geographical Sets:

- i, j—356 supply/demand regions track where wind and solar power are generated and to where they are transmitted. Source regions are generally noted 'i' and destinations, 'j.'
- n, p—134 balancing authorities (abbreviated PCA, for Power Control Authority), each of which contains one or more supply/demand regions, track conventional generation. Source regions are generally noted 'n' and destinations, 'p.'
- *states*—There are 48 states (no Alaska or Hawaii).
- *rto*—32 regional transmission organizations, each of which contains one or more balancing authorities. Reserve margin requirements, operating reserve requirements, and wind curtailments are monitored at the RTO level.
- *r*—There are 13 nerc regions/subregions.
- *in*—There are 3 interconnects.

A.1.2 Temporal Sets:

- *year*—2006 to 2050.
- *period*—There are 23 2-year periods.
- *s*—4 annual seasons.
- *m*—16 time-slices during each year, with four seasons and four daily time-slices in each season plus one superpeak time-slice. (Spring has only 3 slices.)

A.1.3 Other Sets:

- *c*—5 wind classes.
- *l*—3 wind locations (*onshore, shallow offshore, deep offshore*).
- *wscp*—level of wind supply curve.
- *g, bp*—wind growth bracket and break points.

- *ginst*, *bpinst*—wind installations growth bracket and break points.
- *cCSP*—5 Concentrated Solar Power (CSP) classes.
- *cspscp*—level of csp supply curve.
- *gCSP*, *bpCSP*—CSP growth bracket and break points.
- *gCSPinst*, *bpCSPinst*—CSP installations growth bracket and break points.
- *escp*—level of intraregion electricity supply curve.
- *bioclass*—level of biomass supply curve.
- *geoclass*—level of geothermal resource supply curve.
- *egsclass*—level of conductive Enhanced Geothermal Systems (EGS) supply curve.
- *tpca_g*, *tpcabp*—transmission growth bracket and break points.
- *pol*—4 pollutants (SO_2, NO_x, Hg, CO_2).
- *q*—Conventional generating technologies:
  - hydropower
  - natural gas
    - combustion turbine
    - combined cycle
    - combined cycle with carbon capture and sequestration (CCS)
  - coal
    - traditional pulverized coal, unscrubbed, scrubbed, or cofiring
    - modern pulverized, with or without cofiring
    - integrated gasification combined cycle (IGCC) with or without CCS
  - oil-gas-steam
  - nuclear
  - dedicated biomass
  - geothermal
  - landfill gas/municipal solid waste
  - others.
- *st*—There are 3 storage technologies:
  - pumped hydropower (PHS)
  - batteries
  - compressed air energy storage (CAES).